

U.S. Long Baseline Neutrino Experiment Study

April 3, 2006

Preamble:

The Fermilab Proton Driver (FPD) Study conducted in 2004/05 concluded that Neutrino Oscillation physics provides the main motivation for the FPD, and that the physics case is strong. In addition, the Fermilab 8 GeV linac beam could support other physics experiments in parallel with an upgraded NuMI-based neutrino program. The study results were presented to the Fermilab PAC in the 2005 Aspen meeting, and were well received. However, the PAC expressed interest in the possibility of a further generation of neutrino oscillation experiments at a FPD (beyond NOvA) but anchored by the NuMI facility.

Brookhaven National Laboratory has considered in some detail a very long baseline neutrino oscillations (VLBNO) concept using an on-axis, wide band beam but with a very large detector at a longer distance. This beam could originate from either Fermilab or BNL. This approach requires a large underground detector presumably located at the NSF's planned DUSEL facility, which would also have potential for other frontier physics in addition to neutrino oscillation physics.

While these two approaches have a common goal of understanding neutrino masses and mixings, they are clearly different. We would like to have a thorough study and exploration of the differences and potential of the two approaches. To that end we have drafted a charge for a joint Fermilab/BNL study, the results of which could form the basis for a national program in neutrino physics. This charge follows an initial short workshop which laid out some of the issues:

http://www.fnal.gov/directorate/DirReviews/Neutrino_Wrkshp.html

Timescale:

The United States neutrino community is heavily engaged in operation and analysis of its existing program. On the other hand there are active discussions within advisory bodies and the agencies with a view to setting directions for future facilities inside the next year.

It would be desirable to see results of this **U.S. Long Baseline Neutrino Experiment Study** before October 2006, with a preliminary report by July 15, 2006.

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Compare the neutrino oscillation physics potential of:

1. A broad-band proposal using either an upgraded beam of around 1 MW from the current Fermilab accelerator complex or a future Fermilab Proton Driver neutrino beam aimed at a DUSEL-based detector. Compare these results with those previously obtained for a high intensity beam from BNL to DUSEL.
2. Off-Axis next generation options using a 1-2 MW neutrino beam from Fermilab and a liquid argon detector at either DUSEL or as a second detector for the Nova experiment.

Considerations of each should include:

- i) As a function of θ_{13} , the ability to establish a finite θ_{13} , determine the mass hierarchy, and search for CP violation and, for each measurement, the limiting systematic uncertainties.
- ii) The precision with which each of the oscillation parameters can be measured and the ability to therefore discriminate between neutrino mass models.
- iii) Experiment Design Concepts including:

- Optimum proton beam energy
- Optimum geometries
- Detector Technology
- Cost Guesstimate

